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SCIENCE

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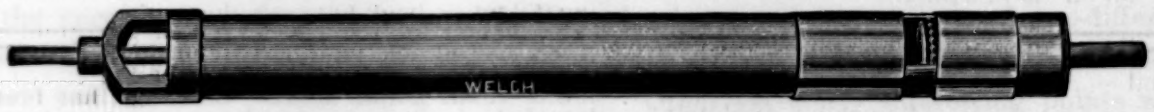

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SCIENCE

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SCIENCE AND SOCIETY

I PROPOSE to-day to compare very briefly the problems of the college graduate of my own time thirty-two years ago and those of the present, and then to point out what seems to me to be the most vital elements which must enter into the solution of the problems which to-day's graduating class will be called upon to face.

I have a very vivid picture of one of America's most constructive statesmen, Senator John Sherman, addressing my own class upon its graduation, and wishing with all his soul that he might be in our shoes.

My generation, said he (and his constructive work covered the fifty years from 1845 to 1895), has had for its great task the preservation of the Union, the assuring to posterity of one unified representative government extending over the whole vast area embraced within the limits of our states and territories, the problem—new in the world's history—of creating the conditions which make it possible to try out democracy on a huge scale. That problem we have solved at an awful expense of money and of human lives. The war for the preservation of the Union is passed, and the process of recovery and reconstruction has been in the main completed. Your problem, young graduates, is to show how well, during the next half-century, you can make that kind of government work in a country three thousand miles one way by two thousand the other.

The half-century since 1891 is now two thirds past, and, if it were fair to shut our eyes to the rest of the world and to take the present situation in the United States as an index of how well we have carried out that task, my generation in America might perhaps look back with a certain complacency upon what it has done so far. Certainly, gauged by the standard of the material prosperity of the average citizen alone, I suppose that it will be generally agreed that in this June, 1923, the United States finds itself better off than any country has ever been at any time in the world's history—considerably better off than it itself was in 1891. Wages have more than doubled since that year, and costs have not yet doubled. The condition of the man at the bottom, whether you consider that man to be the unskilled laborer or the young Ph.D. seeking a job, is better now than it was then, and it is probably immensely better than it has ever been in any preceding period of the world's history. In 1896, after a four-year college course, three years

[1] An address delivered at the Commencement of Stanford University, June 18, 1923.

of work for the Ph.D. degree, and a further year in Germany, I myself obtained a position in physics in the University of Chicago at $800. To-day, under the same circumstances, I might hope to receive from $1,800 to $3,000.

Our intellectual and cultural life has made much progress, too. In 1891 there was very little science in the United States. My friends called me very uncomplimentary names for going in for physics—"The deadest imaginable of subjects." They themselves were going in for that fascinating and at that time new subject of sociology. Since that time the advances in that same dead physics may be said, without a display of too much enthusiasm, to have thrilled the world, while the successes of sociology are more problematical. Physics has opened the eyes of mankind so that it can now see in very truth new worlds—a marvelous world of electrons, already quite well explored, which underlies our former world of atoms and molecules, a world of quanta, not yet well understood, which lies perhaps beyond the ether. And our own country, too, has had a reasonable share in this progress. Also the possibilities that can be seen ahead for further advance, both in knowledge and in physical well being are exceedingly alluring if only stable conditions of society can be maintained so that science can have the opportunity to work out these possibilities.

This amazing progress in science has been reflected in industry too. Since 1891 has come the internal combustion engine which now gives the humblest laborer a car (California has one car for every four and a half inhabitants), the "movie" giving him inexpensive, though as yet perhaps not always wholesome, recreation, the amplifier and the wireless, furnishing the world with a huge nervous system which transmits intelligence practically instantaneously throughout its whole giant frame, the airplane, in which man outsoars the eagle and outspeeds the swift, the X-ray with which he discovers the hidden sources of disease in his body, and antitoxines and antiseptics with which he has already banished forever certain of mankind's most awful plagues.

The discoveries which I myself have seen since my graduation transcend, I think, in both number and in fundamental importance all those which the preceding two hundred years brought forth, and these latter far transcend all those of the preceding five thousand years. Such is the acceleration at which the processes of evolution in human affairs are now going on,—a fact tremendously stimulating or terribly depressing according as one has great faith in man or little.

All these things might have been included in the vision which John Sherman had when he longed to be in our shoes so as to help work out the problems which he saw ahead in a land at peace, prospering under stable republican government and working out its own destiny for the enlightenment, and later, perhaps, for the emulation of other nations not yet free from the domination of Caesars. But what Sherman did not see was that through a vastly more bloody and desperate war than any which his generation had known or even dreamed of, not alone we, the inhabitants of the United States, should be faced in 1923 with the problem of making democracy work on a huge scale, but with us almost every important nation on earth. This problem has now become not merely a national but a world problem—and that, too, before the world was ready for it.

But we can not now go back. The increase in the efficiency of the instruments of destruction has for fifty years been making it harder and harder for any autocrat or oligarchy which gets into control of the machinery of government to be dislodged. Revolution against tyranny can not occur in the future as easily as in the past. Russia to-day, under as fateful a despotism as ever existed anywhere, is a living proof of the disasters which may come to a country which loses self-government, which lets any privileged class whatever, whether represented by a so-called communist like Trotsky, or a "God-ordained" kaiser like Wilhelm II entrench itself in power. With revolution, then, increasingly difficult because of the growth and application of modern science I can see no hope of progress save as society adopts a form of government which permits of progress by *evolution* instead of by revolution, which makes possible the peaceful and gradual replacement of men and policies by new men and new policies when rulers lose their sense of proportion, as men in power are likely to do, and when policies have ceased to be productive of social results. *One of the greatest contributions of science to life is the discovery that progress is in general made by the evolutionary process.* Einstein does not replace Newton; he merely supplements him. *There are no revolutions in science.* In so far as Newtonian mechanics was a body of experimental facts it is eternally true. The whole of Newton is incorporated in Einstein. *Let the revolutionary reformer ponder well that fact.*

The supreme question which the present generation faces is, then, can we make democracy work, not merely for America, but for the world? *Can we replace bullets by ballots?* That question is being asked more searchingly and more fearfully to-day than it was in 1891. The answer to it is to be given in the main by you, young graduates, and by others of like opportunity. *If an affirmative answer is found at all it will be, as I think, because the nations of the earth, including our own, learn to take a more rational, a more objective, a more scientific attitude toward life and all its problems than any of them*

have as yet learned to take. Some wag has said that the anti-evolutionist is opposed to evolution because it never did very much for him. I wish to take that witticism altogether seriously. It is literally true that a good many individuals are still *in the jungle* so far as their method of meeting life's problems, so far as the mainsprings of their conduct are concerned.

For in the jungle ignorance and prejudice and impulse and emotion *must* determine conduct, and *so long as that is the case none other save the law of the jungle is possible.* Man himself is just now emerging from the jungle. It was only a few hundred years ago that he began to try to use the experimental and the objective method, to try to set aside all his prejudices and his preconceptions, to suspend his judgment until he had all the facts before him, to spare no pains to first see all sides of the situation and then to let his reason and his intelligence, instead of his passion and his prejudice, control his decisions. That is called the scientific method. Why? Not because it is applied only in the study of science, but because it has had its most striking development in the sciences, and because it finds its finest application to-day, though not its only one, in the analytical subjects of mathematics, physics, and chemistry. It is because of that method that these sciences have very recently made the astounding strides referred to a moment ago. It is because of it and what it has done already that scientists dare to hope that the law of the jungle can ultimately be displaced by the law of reason, not only in our domestic affairs but in our international ones as well. It is because of it that scientists in general believe that human life may be indefinitely enriched and human happiness enormously multiplied.

But how far are we from the application of that method now, even in our so-called enlightened United States? Let a few illustrations answer. A few weeks ago the daily press reported that the New York legislature had passed a bill requiring that the history of the revolutionary period be taught in the New York schools so as to develop patriotism. The only possible interpretation of that act was that the legislature desired the facts of the revolution to be distorted to suit the prejudices of dwellers in New York. It is fortunate, indeed, that this was the same legislature that has just passed a bill which, whatever its purely legal and technical status, is yet deliberately *aimed at* the nullification within New York State of the present constitution of the United States, since otherwise there would be two such legislatures instead of only one in this country. And yet New York thinks that it is representative at least of the average state of evolution and of intelligence of the country. Let us hope that it is mistaken!

My second illustration, however, is not taken from New York. I recently asked a prominent school book publisher if it would be possible to begin a slow process of eliminating the misunderstandings which lead to war between peoples by inducing publishers of school histories in all countries to submit their proposed school books to three or four international historians of world repute, who would endorse them, if they were able to do so, by the statement that these histories pictured essentially correctly the portions of the field of history with which they dealt. His reply was, "No. It is not yet possible to take such a step in the United States, for the reason that school boards do not yet in this country want history to be taught as it happened. They want something to be called history which pleases their pride and appeals to their prejudices, and I know it because we are ourselves just having our histories attacked in the State of Washington on the ground not that they are incorrect but that they are unpatriotic. And this sort of thing is happening to publishers all over the United States." This means that we are doing in our America to-day precisely what the whole world condemned Germany for doing in all the years preceding 1914, namely, *teaching nationalism in preference to truth.*

The American newspaper which claims to have the largest circulation of any newspaper in the world displays as its motto the words of Stephen Decatur completely inexcusable, at least as they are usually understood, "Our country! May she always be right, but our country right or wrong." It was in very fact the international hates and misunderstandings caused by just that sort of teaching which brought on the great war. And yet there are a dozen American newspapers which are sedulously spreading not merely anti-British but anti-international propaganda of every description.

A British visitor who has traveled and lived in this country recently told me that if his analysis were correct the United States was more likely to start another war than was any nation of Europe. But if another such war as the last is started, I, for one, fear that the world may bid good-by to civilization. I am far from being a pessimist, but the history of central Asia, once at the center of the earth's civilization, and again, the very recent history of Russia, both show that it is possible to destroy civilization completely in a very few years of time. *Let those who deliberately set to work by distortion and untruth, by misrepresentation and cynical mistrust of motives, to stir up class hates and class prejudices in America, reflect well upon these things.* Some of them do it from base motives, because the mob has votes or pennies; others have good enough intentions but neither the intelligence nor the training to catch the scientific spirit and to be able, or even to try, to distinguish truth from falsehood. Well meaning men without poise or any sort of scientific discrimination, and highly trained

and able men without conscience are about equally grave dangers to the wholesome development of human society.

Another glaring example. Look at the storm of protest raised in the United States Senate when Mr. Harding proposed that we begin to try to establish a machinery for settling judicially our international difficulties by joining the Hague court of international justice, a body organized largely through the genius of our own Mr. Elihu Root, and then ask yourself whether that protest was dictated by ignorance and prejudice or by intelligence and the scientific spirit.

But we do not need to go to Washington, to Chicago, or to New York, nor even to the field of politics for all our illustrations. We have, indeed, not yet passed anti-evolution laws in California, but we have many people even here who hasten to condemn evolution without having the remotest conception of what it is that they are condemning, nor the slightest interest in an objective study *of the evidence in the case which is all that "the teaching of evolution" means,* men whose decisions have been formed, as are all decisions in the jungle, by instinct, by impulse, by inherited loves and hates, instead of by reason. Such people may be amiable and lovable, just as is any house dog, but they are a menace to democracy and to civilization because ignorance and the designing men who fatten upon it control their votes and their influence. The churches are often charged by their critics with having more than their share of this type of jungle dwellers, but my own observation is that there are almost as many within the churches who have caught the scientific spirit as there are among the so-called scientists themselves, and many more who have caught what is even more essential to progress, the altruistic spirit. Medical science certainly is full of the jungle dwellers, as is shown by the existence of such a scientific anomaly as sects in medicine. *For science is an objective study of the facts of nature.* It uses any and all hypotheses which assist in correlating these facts, and its many hypotheses have had varying degrees of success in making such correlations, but science never commits itself as a matter of faith to any of them, not even to evolution. When it does so it ceases to be science.

But what, now, is the remedy? Is there any hope for the improvement of the situation and the elimination of the dangers which threaten the permanence and success of our modern society inside our commonwealth and outside of it? I have no nostrums to propose. The longer one lives the less confidence does he have in any universal formula. The situation itself which I have portrayed suggests the only solution which there can be, namely, the slow growth of a larger degree of *both public intelligence and public conscience than we now have. Intelligence enables one to know better what he ought to do, while conscience keeps him doing as he knows he ought.* In America the school has concerned itself primarily with the first field, the church with the second. Which will play the larger rôle in getting us out of the jungle I will not attempt to say, but it appears to me fairly obvious that without both of them human society is headed for the rocks. But science, imbued with the spirit of service, which is the essence of religion, and religion guided by the intelligence, the intellectual honesty, the objectiveness, and the effectiveness which is characteristic of the spirit of science, can between them, without a shadow of a doubt, in view of the rate at which discoveries are now being made and at which changes are being brought about, transform this world in a generation. If that transformation actually gets very far in your lifetime, members of the class of 1923, it will be because of the following sorts of influences:

First, it will be because you graduates, and others of your opportunities, act as centers for the growth in the communities in which you live of both the scientific spirit and the altruistic spirit, and a relatively few such centers can accomplish wonders, for most men follow while but few men lead. It will be because you do not sit idly and thoughtlessly by expecting that leadership to come from New York or Chicago or other great centers of population. Remember that Athens, with its hundred thousand Greeks, did more to shape the development of the race than any city of fifty times its population has ever done, and that an insignificant village in Galilee did more than Athens. The only way in which public sentiment, the sovereign power in a democracy, can be developed is by having hundreds and thousands of such centers as you may yourselves create in the communities in which you live. There is nothing new nor spectacular about that remedy any more than there is about any of the processes of growth, but these are, after all, the processes by which most of the progress of this world comes about.

Secondly, I think that you or some one else, will soon take steps to so reorganize the teaching of science in the public schools as to give a larger fraction of the pupils who go through our high schools and colleges more training, particularly in the mathematical and physical sciences, for from my point of view there is no training in objective, analytical thinking, nor in honesty and soundness of judgment, which is comparable to the training furnished by these sciences. I know of no training for life which is equal to it, whether one is to be an engineer, lawyer, business man, or preacher. It is an exceedingly wholesome thing to work at some time in one's life in a field in which *the distinction between right and wrong, be-*

tween loose and correct thinking, can not be obliterated or escaped; to learn that there are eternal physical laws and presumably also eternal esthetic, moral, and social laws in conformity with which one must proceed if he is to arrive at correct results; to learn, too, that four fifths of all the experiments which we make in our physical laboratories in the hope of developing new relations, establishing new laws, or opening up new avenues of progress, are found to be directed along wrong lines and have to be abandoned. There is no reason to suppose that any larger percentage of the efforts which are made toward social, political, or educational reforms are in the actual direction of progress. With a better realization of these facts we should have less worship of the new *merely because it is new,* fewer cubists in art, in literature, in education, in politics, in social reform. One of the well-known residents of Southern California who had a fine training in physics and mathematics but has spent his later life as a farmer and fruit grower said to me the other day, "I do not use my science much on my ranch. I guess and blindly follow tradition almost as much as my neighbors, but I know *when I don't know* and they do not. That is worth all my education cost me." If such a change in our public school curriculum as I am suggesting is brought about at all, it is going to be done, I think, through a reorganization of the required group of studies rather than by important changes in methods of instruction in the individual sciences. This is primarily a matter of the public schools.

In the third place, public spirited men are going to see more and more that the support in a large way of scientific research is an investment which brings the largest returns of satisfaction to themselves and of progress to mankind which can be made at all. It is my own belief that no efforts toward social readjustments or toward the redistribution of wealth, such as so many well meaning people are urging in a thousand different ways, have one tenth part as good a chance of contributing to human well being as have the efforts of the physicists, the chemists, the biologists, and the engineers toward the better understanding and the better control of nature. The distribution of wealth can, of course, be improved, and I welcome every constructive and sane effort toward its improvement, but the results which can be accomplished for the well being of mankind by efforts in this direction seem to me to be utterly trivial in comparison with those which may be brought about by physical and biological research. An eminent and progressive economist told me lately that no sort of redistribution of the wealth now available could possibly add more than ten per cent. to the income of the average man, and probably much less than that. To replace for the toiler a dollar meal by a dollar and ten cent meal is scarcely my idea of the millennium.

In the fourth place—and this is in my opinion most important of all—*the spirit of religion and the spirit of science are going to join hands,* because the leaders of both religion and of science are coming increasingly to see life as a whole instead of from the pathetically narrow and unscientific point of view from which some in both fields have in the past looked upon it. This is one of the places at which you young graduates have your greatest opportunity to exert a very large influence upon your generation.

I should like, in closing, to call the attention of any man who is wondering whether after all there is any progress, whether mankind gets farther away from the method of the jungle, and develops any more of the spirit of science, or of the spirit of service than he had in the past, to two recent events. Both of these events seem small, but I think they are pregnant with meaning and with encouragement for the man who has begun to wonder whether human society can ever really catch both the *scientific spirit and the altruistic spirit* and realize the immense possibilities which are before it when it does.

My first event is in the field of medical education. I am informed by my medical friends that the medical fraternity has actually educated itself up to the point where allopaths and homeopaths have got together, to abolish, so far as they themselves are concerned, sectarian schools of medicine. The last of these particular sectarian schools, so I am told, has gone, having been simply and rationally combined into schools which teach merely *medical science* as it is known today. Truly "the thoughts of men *are* widened with the process of the suns!"

The second ground for encouragement is found in the following fact: A statement upon the relations of science and religion was recently drawn up, which Bishop Johnson of Los Angeles characterized as a "thoroughly pious statement." It asserted that religion and science were not only not antagonistic, but that both were necessary to the progress and the happiness of mankind. Further, this statement definitely recognized God, for whom I myself want no better definition than that given by Tennyson when he wrote, "For I doubt not through the ages one increasing purpose runs," and it definitely assigned to religion an even more important place in human life than to science. On the other hand, it called for the recognition by all the signers of the scientific method. *Fifteen sixteenths of all the scientists to whom that statement was submitted signed it at once without a question as the statement of their belief,* and these men were chosen, let it be remembered, solely because of their outstanding character as scientists and with-

out any knowledge of their religious views. Three fourths of all the men of affairs approached signed and none expressed dissent, a few, however, preferring for political reasons not to join in the statement. Two thirds of the religious leaders who were interrogated signed, most of whom were of the more conservative groups. The response of the scientists is particularly significant and possibly has some bearing upon the breadth of view developed by scientific training. After this showing who is he who is asserting that science is materialistic and irreligious? There are a few scientists, it is true, but only a few, who forget the scientific method when they touch the field of religion and scoff at it without knowing anything about it, and these men, too, have their exact counterparts, perhaps in slightly larger numbers, in the field of religion where there is, I regret to say, a group of blind leaders of the blind, men who still follow the method of the jungle and are still imbued with its spirit of prejudice, preconception and intolerance. Yet there is here the best of evidence that the leadership in both science and religion is in the main imbued with both the spirit of intellectual honesty and objectiveness which is characteristic of science, and the spirit of altruism and service which is the glory of religion. *This combination is the only nostrum which there is for human ills, the only hope for a paradise on earth, and each of us has the opportunity to do his bit toward bringing it about.*

R. A. MILLIKAN

NORMAN BRIDGE LABORATORY OF PHYSICS,
CALIFORNIA INSTITUTE OF TECHNOLOGY,
PASADENA, CALIFORNIA

THE BUILDING OF THE NATIONAL ACADEMY OF SCIENCES[1]

THE architectural character of the building has been largely determined by its surroundings, being what Charles Moore calls the "Spirit of Washington." While classic in its appearance, it is not severely formal and lacks the rows of columns so familiar to the visitor to the National Capital.

The general character of the exterior is Greek even to the varying of the height of the masonry courses.

Across the doorway is a marble pseudo-pediment, wherein the sculptor has portrayed the elements with which science and scientific research deal—Earth and Cloud through the various forms of the Vegetable and Animal Kingdom to Man. At the apex is the Sun—the source of warmth and light.

[1] Abstract of a memorandum to the Carnegie Corporation of New York on the building designed by Bertram G. Goodhue for the National Academy of Sciences and the National Research Council, and the progress of its construction.

A great range of window openings two stories in height, three each side of the entrance, is filled between the upper and lower windows with low relief bronze panels figuring the outstanding Founders of Science from earliest times.

Within the main doorway lies a simple vestibule from which the great Foyer Hall is entered. At the beginning and end of this hall are elaborate grilled glass screens with panels of the Zodiacal signs set in an intricate framework of bronze. The ceiling is of cedar—colored and gilt. On either side of the hall are staircases and elevators. On the left beyond these is the library, and still further beyond, its attendant reading room occupying the very end of the building.

In the right wing of the building balancing the library is the small Lecture Hall, and beyond it the Meeting Room. The library takes the form of a central aisle with alcoves on either end. All here is of masonry and metal, even to the bookshelves.

The Reading Room is of more domestic appointment, panelled in walnut for about two thirds of its height, with a ceiling of walnut. The space between is now of plaster but may eventually be filled with a painted frieze.

The small Lecture Hall has been designed mainly with a view to its acoustic qualities. Above the high wainscoting of wood and panel, the wall is of acoustic tile. The ceiling and its heavy beams are of plaster.

The Meeting Room next to the Lecture Room is of the same size and proportion as its counterpart, the Reading Room at the extreme other end of the building, but it is less domestic in character on account of its purpose. As in the Library and Reading Room there is an ample fireplace.

The second screen in the Foyer Hall leads into the main Auditorium, which is cruciform in shape, the four arms being vaulted to support a central pendentive dome. The floor is of marble and green slate and three balcony fronts, each supported by two shafts of Verde antique marble, are of walnut with various inlays of other wood. The walls to the center of the arches are of acoustic tile and are as simple as possible in character and surface.

Above the spring, the arches and dome are genuinely vaulted and covered with acoustic tile, in its turn covered with elaborate decoration with panels of figures and emblems, the whole colored and gilt.

In the apex of the dome is an "eye," which is an accomplishment of scientific engineering. The roof of this "eye" swings upon itself in a way that permits the direct rays of the sun to enter at all periods of the year and day, and be projected to a spectrograph at the level of the floor under the dome. From this "eye" also depends a Foucault pendulum to demonstrate the rotation of the earth.

Both pendulum and spectrograph are removable

when occasion demands. The support of the spectrograph is bronze covered with figures of Sun gods in low relief. In this room under the dome, which constitutes the Main Auditorium, again there are motion picture booths with a screen provided behind the Speaker's Tribune.

Around the central auditorium lie seven exhibition rooms, three large and four small, to put promptly before the public important current discoveries and inventions in Science. These rooms are very simple in their character but each one has been carefully studied for the purpose to which it is to be put.

Besides the various workaday offices in the second and third floors for the National Academy of Sciences and the ten divisions of the National Research Council, the basement contains a large two-story stack room for the library, as well as certain public exhibition rooms from which daylight must be excluded.

The general contract was let on April 11, 1922, to Charles T. Wills, Inc.

Prior to the letting, the exploratory work encountered difficulties in the foundations, increasing the cost in the neighborhood of $50,000, due to an ancient stream bed covered up when the land—which is made land—was filled in many years ago.

The foundation walls rest on reinforced concrete girders, which in turn rest on 74 concrete piers five feet square to bed rock and the girders supporting the terrace rest upon 33 large steel tubes driven to bed rock, emptied and filled with cement.

The dome over the Rotunda is rapidly rising.

In general the project is about 75 per cent. completed. Nothing has been started on the grading of the site for carrying out the plans for the grounds, which involve a main approach with side approaches, reflecting pools and other landscape features.

Through the efforts of the National Academy of Sciences, Congress was induced to close Upper Water Street, adding the area of this street to the Academy-Research Council quadrangle, which because of this now comprises the whole area enclosed between B and C Streets, from 21st to 22nd Streets, and in effect becomes part of the park in which the Lincoln Memorial stands.

Out of the $1,350,000 appropriated for construction by the Carnegie Corporation, $713,128.37 has been spent. Prospective and actual over-runs in cost amounting to $55,656 beyond the original estimate, due to rising costs and unforeseen contingencies, have been encountered, but in an effort to compensate for these, prospective savings and reduction of scope amounting to $42,876 have been made.

The period has been one of rapidly rising costs produced by nation-wide congestion in the labor and material markets. The main contract could not be re-let now for less than $250,000 more.

The land purchased by the National Academy of Sciences through funds amounting to $185,000, raised by subscription, is in a most favorable location opposite one face of the Lincoln Memorial, with which the white marble Greek style of the Academy-Research Council building is in harmony.

The building is attracting unusual attention and its advent will signalize a very important step in the development of science in the United States.

GANO DUNN
Chairman, Joint Building Committee, National Academy of Sciences, National Research Council

CHARLES NEWTON LITTLE

PROFESSOR LITTLE, dean of the college of engineering in the University of Idaho, passed away suddenly from heart failure in Berkeley, California, on September 7.

He was born of missionary parentage at Madura, India, in 1865. He was a graduate of the University of Nebraska, where he took the A.B. degree in 1879 and the M.A. degree in 1884. He took his degree of Ph.D. at Yale in 1885 and afterward studied in Germany with Klein and Hilbert. His work in the theory of knots was of fundamental importance. By methods which he invented and perfected he succeeded in enumerating and classifying the different kinds of knots up to those of the tenth order. This work attracted the attention and interest of Professor Tait, of the University of Edinburgh. Professor Little's work was published in the *Proceedings* of the Connecticut Academy of Sciences and in the *Transactions* of the Royal Society of Edinburgh. In the last few weeks of his life, on being relieved of his duties as dean of the college of engineering, he turned again to these researches and under the inspiration of sympathetic associates he was laying his plans for another assault on this most difficult field of analysis situs. His untimely death is a very serious loss to mathematics.

As a teacher he may be known by his fruits. He was ever vigilant in the upholding of high standards of scholarship. Earnest and enthusiastic and inspiring, inflexibly following his own high ideals, he was a man to be reckoned with by those who would take the easy and popular roads in educational matters. As a man, he was entirely lovable. Loyal to his friends, with malice toward none of those who failed to understand his devotion to what he believed was right, he has left behind him an imperishable record of a well-spent life.

D. N. LEHMER

SCIENTIFIC EVENTS

THE INTERNATIONAL HEALTH BOARD OF THE ROCKEFELLER FOUNDATION

SECTIONS of the report of the International Health Board of the Rockefeller Foundation for 1922, made public in advance of the general distribution of the volume, show that during the year the board worked in cooperation with the governments of seventy states and countries throughout the world.

The activities reported include a review of the history and objects of the International Health Board; the campaign against yellow fever in Mexico and South America; surveys, field experiments and demonstrations in malaria control at home and abroad; world-wide efforts in the control of hookworm disease; the extension of county health work in the United States and Brazil; the development of public health laboratory services, public health nursing services, and schools of hygiene in various countries; cooperation with the health section of the League of Nations; and the extension of training through fellowships.

The International Health Board had its inception in an organization known as the Rockefeller Sanitary Commission, established by Mr. John D. Rockefeller in 1909, which in 1913 was supplanted by the International Health Board, created by the newly organized Rockefeller Foundation with the immediate object of extending "to other countries and peoples the work of eradicating hookworm disease as opportunity offers, and so far as possible to follow up the treatment and cure of this disease with the establishment of agencies for the promotion of public sanitation and the spread of the knowledge of scientific medicine."

Reviewing briefly the activities of the board since 1913, the report points out in the following paragraphs the fundamental principles on which its work has been based.

In the course of almost ten years of cooperative service with government authorities, hookworm infection the world over has been measurably diminished; progress has been made toward reducing the ravages of malaria; and a relentless campaign is still being waged against yellow fever wherever its danger flag appears. From the outset, however, the board has maintained the conviction that public health is essentially a function of government. No private and temporary agency, whatever its resources, could or should discharge responsibilities which, by their nature, belong to the constituted authorities of the commonwealth. Private enterprise, therefore, may be best employed in awakening public opinion and thereby encouraging state and county officials to establish permanent agencies for public health work. Responsibility for the control and cure of any one disease has never been assumed by the board; but aid has been given in control and cure where such steps might be expected to demonstrate a need and suggest a possible program.

Lastly, it has been clearly recognized that continued advance in preventive medicine the world over depends upon an adequate supply of skilled public health servants. Research has been aided in special cases where it might lead to the more effective application of existing knowledge to the control of disease. Training schools for health officers, nurses and visitors have been promoted; contributions have been made toward the establishment of schools of public hygiene. And finally, the fruits of these enterprises have been made accessible to a broader circle by means of international fellowships.

The demonstration and cure of disease arouses a public sentiment which expresses itself in legislative appropriations for specific and general health purposes. Progress on the administrative side, in turn, creates a demand for technically trained men and women to carry out new programs. Thus public enlightenment, government machinery and technical education and research are bound up in a sure sequence which may be traced in some of the activities of the board during 1922.

EXPLOSION AT THE BUREAU OF STANDARDS

THE *Journal* of the Washington Academy of Sciences gives the following account of the explosion at the Bureau of Standards:

On the afternoon of September 20 a violent explosion followed by fire occurred in the Dynamometer Laboratory of the Bureau of Standards. One man was killed instantly, three others injured so seriously that they died during the night, and four others seriously burned or cut. The heroism of the survivors of the staff in rescuing the injured from the furiously burning wreckage and in shutting off the electric circuits and the ammonia valves minimized the loss of life and property.

The explosion occurred in the altitude chamber which is used in testing the performance of aircraft engines under the conditions of low pressure and temperature obtaining at high altitudes. At the time of the accident the room was being used in investigating the performance of an automobile engine, at temperatures corresponding to winter operation, using various grades of gasoline. The work was intended to determine the possible increase in gasoline production per barrel of crude oil, with the accompanying conservation of our national resources, by the use of gasoline of lower volatility.

The explosion was due to the ignition of an explosive mixture in the chamber.

The dead are: Logan L. Lauer, Urban J. Cook, Stephen N. Lee, Joseph Kendig. The injured are: Henry K. Cummings, Frank E. Richardson, Roger Birdsell, George W. Elliott, C. N. Smith, R. F. Kohr.

Most of these men were college graduates with experience and skill in research work, and a grave blow to science and engineering must be added to the human loss to their families and colleagues. Thus grows the long list of those who have given their lives for the increase of human knowledge and welfare.

THE ALDRICH COLLECTION OF DIPTERA

THE National Museum has recently received as a gift from Dr. J. M. Aldrich his private collection of Diptera. This collection was begun in 1890, and for 28 years received a good share of the owner's efforts; since he went to the National Museum in 1918 it has, however, received no additions. A recent inventory showed it to contain 44,610 pinned specimens and 4,145 species fully named; 534 of the latter were represented by type material. There are some hundreds of undescribed species; and as Dr. Aldrich collected for many years in the Pacific Coast and Rocky Mountain regions, his collection contains many named species not heretofore represented in the National collection.

Dr. Aldrich also donated to the museum his card index of the literature of North American Diptera, begun in 1898 and now extending to about 70,000 references as nearly as can be estimated. With the exception of about 20 hours' work, this is all by the hand of the owner himself, and represents to a large extent his own conclusions from the literature rather than a mere compilation.

In a letter to his chief presenting the collection and index, Dr. Aldrich states that he was deterred from taking this action sooner because the salaries paid by the museum are still on the scale established in 1882 (except for a temporary war bonus of $240), and he did not feel sure that he could continue permanently as one of the curators. Recently, however, under the reclassification act passed by the last congress, the museum staff have been assured of a new pay schedule approximating the requirements of the present time.

HARVARD COLLEGE OBSERVATORY

THE Harvard College Observatory, entrances on Concord Avenue opposite Buckingham Street and on Garden Street opposite Linnaean Street, will be open to visitors from 7:30 P. M. to 9 P. M. on the dates given below.

A short talk, generally by a member of the observatory staff, will be preceded, when the weather permits, by telescopic observations of celestial objects. Exhibits showing the work of the observatory will be explained by members of the staff.

Tickets for the open nights must be obtained in advance by writing to the Harvard College Observatory, or telephoning University 0390 between 9 and 11 A. M. There is no charge for admission. Applicants will be assigned tickets for one night only.

The dates, titles of lectures and speakers are as follows:

Monday, October 29—"Eclipses of sun and moon," Professor H. T. Stetson, Harvard University.

Wednesday, November 14—"The variation of stars," Mr. Leon Campbell.

Tuesday, November 27—"Stellar motions," Dr. Willem J. Luyten.

Wednesday, December 5—"The origin of the earth," Professor Harlow Shapley.

Thursday, December 13—"Ancient and modern telescopes," Professor Edward S. King.

Friday, January 11—"Nebulae," Professor John C. Duncan, Wellesley College.

Thursday, January 31—"Harvard observatories in Chile and Peru," Professor Solon I. Bailey.

CELEBRATION IN HONOR OF PROFESSOR E. H. S. BAILEY

DR. EDGAR HENRY SUMMERFIELD BAILEY, professor of chemistry at the University of Kansas, was signally honored on September 21, when the University of Kansas, the Kansas Academy of Science and the Kansas City Section of the American Chemical Society joined with the Department of Chemistry of the University in an anniversary celebration which marked the completion of his fortieth year of service at the university. It was not only the unique distinction of having served one institution for four decades that inspired this celebration, but also the fact that during these four decades Professor Bailey has enriched the science of chemistry by the publication of some one hundred papers, largely the results of his own researches, and the publication of several books of recognized scientific value, and also as director of the chemical laboratories, has built up a strong department which has turned out many men who have attained distinction in their special fields. Many of these men returned on this occasion to honor Professor Bailey, and many who could not come sent congratulatory messages.

The afternoon program consisted of two addresses by former students of Professor Bailey: Dr. E. C. Franklin, president of the American Chemical Society, who spoke on "Systems of Acids, Bases and Salts," and Dr. E. V. McCollum, professor of biochemistry at Johns Hopkins University, whose topic was "The Present Status of our Knowledge of Nutrition."

In the evening, at a banquet attended by two hundred, appreciation of Professor Bailey's kindly disposition, efficient service and lasting contributions was voiced by speakers representing the organizations in which he has been most active. Dr. Frank Strong, ex-chancellor of the University of Kansas, acted as toastmaster on this occasion. The Honorable D. O. McCray, representing the governor, spoke for the State of Kansas, Chancellor E. H. Lindley for the University, Dr. E. C. Franklin for the American Chemical Society, Dr. J. T. Willard for the Kansas Academy of Science, Dr. E. V. McCollum for the

Alumni, Dr. H. P. Cady for the Department of Chemistry, Professor Sidney Calvert for the University of Missouri, and Harold Greider, representing Director E. R. Weidlein, for the Mellon Institute. Professor Bailey spoke in response to the presentation of an appropriately engraved silver vase, which was made to him in the name of his colleagues and former students. G. W. S.

SCIENTIFIC NOTES AND NEWS

THE local committee for the meeting of the National Academy of Sciences, to be held at Cornell University from November 12 to 14, consists of Professors Edward L. Nichols, *chairman;* Ernest Merritt, L. H. Bailey and W. D. Bancroft. A business session of the academy will be held on Monday morning, November 12. An open meeting immediately afterwards will begin with a brief address of welcome by President Farrand. The afternoon has been left open for informal gatherings of the members, inspection of buildings, sightseeing or other recreation. It is proposed to arrange a public lecture for the evening. Meetings for the presentation of papers will be held in the morning and the afternoon of Tuesday. President and Mrs. Farrand will receive the visiting members and their friends at the president's house from 4:30 till 6 P. M. A dinner will be held in the evening. A morning session is planned for the presentation of papers on Wednesday.

ON the occasion of the dedication of the Jesse Laboratory of Chemistry at Brown University on October 10, the degree of doctor of science was conferred on Professor James W. McBain, of the University of Bristol, who made the principal address. The degree of doctor of laws was conferred on President James R. Angell, of Yale University. Secretary of State Charles E. Hughes made the chief address at the dinner.

A MEMORIAL service for the late Dr. Henry Marion Howe, the distinguished metallurgist, for many years professor at Columbia University, will be held at the Cathedral of St. John the Divine at 5 P. M. on October 25. Among the speakers will be Professor M. I. Pupin, of Columbia University.

IN addition to giving the Silliman lectures at Yale University, Dr. Niels Bohr, professor of physics in the University of Copenhagen, is giving the Simpson lectures at Amherst College.

G. F. LOUGHLIN has been made acting chief of the section of metalliferous deposits, division of geology, in the U. S. Geological Survey.

WILLIAM B. HILL has been elected president of the board of trustees of the Hoagland Laboratory of Brooklyn, said to be "the first laboratory in this country to have been built and privately endowed for bacteriological research and the advancement of medical science."

COLONEL CHARLES KELLER, of the Corps of Engineers, has been retired from active duty in the army after more than thirty-seven years of service. He is now engaged in the solution of engineering problems in connection with waterpower development on the Pit River in California.

PROFESSOR EUGENE E. HASKELL, formerly dean of the College of Civil Engineering of Cornell University, who has more recently been emeritus professor of experimental hydraulics, left Ithaca on August 20, with Mrs. Haskell, for Hamburg, New York, where they will make their home. Dean Haskell has retired from active engineering duties, but will occupy himself in a consulting capacity in his profession with Buffalo associates.

WILLIAM B. PLUMMER, formerly research chemist for the Grasselli Chemical Company, is now associated in the same capacity with the Combustion Utilities Corporation, Long Island City, N. Y.

RICHARD FISHER, formerly of the chemistry department of the University of Illinois, has accepted a position as research chemist with the same company.

DR. L. EMMETT HOLT has been assigned as visiting professor of pediatrics to the Peking (China) Union Medical College, by the Rockefeller Foundation. Dr. Holt, who is on his way to the Orient, will conduct a three months' series of lectures. He will also make a survey of child health methods as practiced in various countries and plans to return to New York next summer.

DR. LEE DE FOREST returned from Europe on October 1, on board the French liner *Paris*. Dr. de Forest brought with him a device known as the oscillating audion which he said would greatly facilitate broadcasting.

PROFESSOR R. C. GIBBS, professor of physics at Cornell University, will spend the coming year on sabbatic leave as an associate in the research department at the California Institute of Technology at Pasadena.

AT the recent centenary of the Royal Asiatic Society held in London, Professor James H. Breasted represented the University of Chicago and Professor Albert T. Clay of Yale University.

DEAN R. L. SACKETT, of the school of engineering at the Pennsylvania State College, is visiting technical colleges and universities in Europe.

MR. F. W. TAYLOR is engaged in the work of starting several agricultural experiment stations for the government of Salvador, Central America. He may be addressed in care of the American Legation at San Salvador.

DR. WALTER R. BLOOR, of the School of Medicine and Dentistry of the University of Rochester, will deliver the second Harvey Society Lecture at the New York Academy of Medicine, on Saturday evening, November 3. His subject will be "The utilization of fat in the animal body."

DR. CALATAYUD COSTA, professor of electrology and radiology of the University of Madrid, has been invited to lecture at the Battle Creek Sanitarium and at certain universities in this country.

THE death is announced of Professor Tomasso Salvadori, of Turin, known for his work in ornithology.

MR. JOHN D. ROCKEFELLER, Jr., has given $500,000 toward the endowment fund of $2,000,000 of the New York Zoological Society and will contribute $500,000 more as soon as the society raises another million. Mr. Edward S. Harkness has subscribed $100,000 and the estate of Mrs. Frederic Ferris Thompson $50,000. For some time the society has been carrying educational, philanthropic and civic burdens far beyond its financial resources. Mr. Rockefeller's gift is without restrictions and its income becomes immediately available.

F. J. WILLSON, a member of the board of commissioners of Cook County, and chairman of the county committee on a zoological park for Chicago, reports that as approved by the legislature, the county is prepared to submit to the voters in November a proposed tax of $500,000 a year for five years and $250,000 a year annually thereafter. The larger sum is to equip the Zoological Park, the smaller to maintain it after it is established. Land for the proposed park at Riverside in the Cook County Forest Preserves, where the animals will be exhibited on a plan which will allow them to roam free, instead of confined in cages, was a gift to the county board for the purpose. Recently the board signed a twenty-five year contract which turns over the management to the Chicago Zoological Society.

THE Society of Chemical Industry will meet in Paris from October 20 to 25. It will be particularly devoted to the agricultural applications of chemistry.

THE sixtieth anniversary of the founding of the Entomological Society of Ontario will be celebrated by a series of meetings to be held in Ottawa on November 1, 2 and 3.

WE learn from *Nature* that the International Commission of Eugenics met at Lund in Sweden on September 1 and 3 under the chairmanship of Major Leonard Darwin. Various resolutions were passed, and the question where the next international congress should be held was discussed. Professors Nilsson-Ehle and Johansson were appointed members of the commission. The commission was entertained at dinner by the Mendelian Society and visited the Swedish Institute of Genetics at Akarp, near Lund, and the Swedish State Institute for Race Biological Investigation. These are the only institutions in the world for genetics or eugenics which are state-endowed.

THE sixth annual joint convention of the American Sections of the Science Society of China and the Chinese Engineering Society was held at Brown University, Providence, R. I., from September 7 to 15, inclusive. Seventeen papers were presented at the forum meeting and the technical sessions. Most of these papers will be published in "Science" (Chinese), the official organ of the Science Society of China. Among the papers were "Some Theories in Combinatory Analysis," by C. J. Chin, of the University of Chicago; "The Effect of Hydrostatic Pressure on the Magnetic Permeability of Iron, Cobalt and Nickel," by C. S. Yeh, of Harvard University; "Production of Non-Corrosive Alloys," by E. C. Y. Cheng, of Columbia University. These papers will probably appear in *American Journal of Mathematics, Physical Review* and the *Journal of American Electro-chemical Society,* respectively. The speakers of the convention included Mr. J. R. Freeman, ex-president of the American Society of Mechanical Engineers and the American Society of Chemical Engineers; Professor Harold B. Smith, director of Electrical Engineering Department of Worcester Polytechnic Institute, and Dr. J. A. L. Waddell, consulting engineer.

THE next meeting of the American Electrochemical Society will take place April 24, 25 and 26, 1924, in Philadelphia, with headquarters at the Bellevue-Stratford. The principal attractions of the technical program will be the two Symposia, as follows: "Recent progress in electrodeposition," S. Skowronski, research chemist, Raritan Copper Works, Perth Amboy, N. J., *chairman,* and "Organic electrochemistry," C. J. Thatcher, chemical engineer and electrochemist, New York City, *chairman.*

A PARTY of British medical students has recently completed a Continental tour under the auspices of the National Union of Students of Great Britain, a body affiliated to the International Confederation of Students. The party comprised members of the Universities of Oxford, London, Manchester, Liverpool, Leeds, Edinburgh and Glasgow; and the medical centers visited included Paris, Brussels, Vienna, Prague, Berlin, Munich, Leyden and Zürich.

APPOINTMENT of an unpaid commission to supervise the organization of medical research workers was recommended by M. Douglas Flattery, of Boston, chairman of the special committee on medical research, during a conference with President Coolidge on October 9. Mr. Flattery also recommended the enactment of legislation for a national study of preventive medicine. This is in line with a recommendation made to President Harding about two years ago, which was discussed and approved by the cabinet. At that time President Harding referred the matter to Brigadier General Sawyer, his personal physician, to make such other recommendations as might seem suitable to him. The plan included the organization of all scientific workers in such colleges and laboratories as have laboratory equipment together with chemists, physicists, biologists, bacteriologists, physiologists and other scientific men working in related fields.

UNIVERSITY AND EDUCATIONAL NOTES

SUIT was filed in the circuit court on October 1, asking approval of the plans to raze the old Rush Medical College buildings at Harrison and Wood Streets, and to erect a $400,000 building to be known as the Rawson Clinical Laboratories, for which Frederick H. Rawson donated the sum of $300,000. The University of Chicago, according to the plan, will take over the property and build the new laboratory. A contract between the college and the university has been tentatively adopted, pending the approval of the court. A program which provides for the expenditure of $5,300,000, gifts to the university for the advancement of medical education, is to be carried out, the bill states, and includes the building of a hospital of 200 beds on the university campus.

THE president of Cuba has issued an order establishing a university governing assembly. It is to consist of thirty professors, thirty alumni and thirty students, and this body will have charge of the management of the university.

DR. WILLIAM M. MARRIOTT, chief of the department of diseases of children, Washington University Medical School, St. Louis, has been appointed dean of the school to succeed Dr. Nathaniel Allison, who becomes professor of orthopedic surgery at Harvard University Medical School, Boston.

PROFESSOR C. W. PARMELEE has been made head of the department of Ceramic Engineering at the University of Illinois, where he has been professor since 1916.

PROFESSOR J. W. MCCOLLOCH, of the Kansas State College, has been named acting head of the entomology department at the college during the absence of Professor G. A. Dean, who has a year's leave of absence.

DR. ALFRED S. ROMER has been appointed associate professor of vertebrate paleontology in the University of Chicago. Dr. Romer has been working in the American Museum of Natural History and the department of anatomy of New York University.

EDWIN B. POWERS, associate professor of anatomy at the College of Medicine of the University of Tennessee, at Memphis, is on leave for the year to take charge of the department of zoology of the University of Tennessee at Knoxville.

DR. CHARLES F. MARTIN has been appointed dean of McGill University faculty of medicine to succeed Dr. George E. Armstrong.

DR. GEORGE D. PORTER has been appointed head physical director at the University of Toronto to succeed Dr. James W. Barton, who resigned last spring.

DISCUSSION AND CORRESPONDENCE

THE SIGNIFICANCE OF THE "FOLIAR RAY"

IN a recently published article entitled "The significance of the 'Foliar Ray' in the evolution of Herbaceous Angiosperms" it becomes evident that the authors now have their facts in hand. May we ask that they will credit us with the same elementary common sense. The difference of opinion seems to have resolved itself mostly into a question of terminology. In the original article by Messrs. Sinnott and Bailey which appeared in 1914 there was a fundamental misconception. The bands of "interfascicular parenchyma" found in herbaceous stems are decidedly not the homologues of the radial bands which subtend the leaf traces. The attribution of such an idea to "Jeffrey and his school" was a mistake and the demolition of this man of straw has wasted much valuable journal space.

The writer believes that our critics still fail to realize the importance of nodal modifications around incoming leaf traces where storage is initiated. That the thinning of the stem and consequent obliteration of the radial storage ray led to the vertical extension of the flanking portions is still our own belief. Incoming food must be stored somewhere, and if the old storage region is being obliterated through a reduction in the foliar parenchyma outside the trace what is more logical than to suppose that the flanking tissue played up to fit the new situation.

Conversion of tracheidal tissue into parenchyma on

the flanks of a leaf trace may be called "widening of medullary rays" if one finds greater satisfaction in such a designation. In teaching the herbaceous stem, however, the writer has found that the student grasps the situation better when he realizes that the subtending nodal ray and the parenchyma which flanks the trace on either side are but parts of one physiological system specialized for food storage. As to its actual phylogeny this tissue would seem to represent a complex of vertical parenchyma united with vertical series of rays, but since the same thing can be said of the subtending ray there is no real difference between them. The flanking tissue is certainly not a single ray broadened out. Our critics are in danger here of setting up the same subtle doctrine of specificity of tissues that animates those realists who are so obsessed by the Platonic Idea of the stele that they can sense imaginary lines running across a leaf gap to separate cortex from pith.

As to the fact that some trees and shrubs have foliar rays, that would seem to have been known for some time. In fact it serves as the very basis from which the theory takes its departure. The damning fact that certain herbaceous stems, on the other hand, have "essentially continuous vascular cylinders" is to be regretted, perhaps, but it only shows that nature refuses to be forced into ways of absolutism in her operations.

So far as the writer can see we have come to a substantial basis of agreement as to facts.

Messrs. Sinnott and Bailey admit that foliar rays may occur in aerial stems, and they realize that "high multiseriate rays" or flanking storage parenchyma of a leaf trace is not the same thing as a subtending ray, hence they won't search any longer for leaf traces on the central side of such a flanking band.

The writer, on his part, is willing to call flanking tissue a medullary ray, though truth to tell, both terms are poor ones for the tissue in question. Further he gladly admits the existence of trees with leaf rays and herbs without any.

So all considered we come to substantial agreement as to how a tree became an herb. As far as the writer is concerned the affair is closed.

R. E. TORREY
MASSACHUSETTS AGRICULTURAL COLLEGE

FEMORAL DEFORMATION

DURING an examination of skeletal material from an archeological site at Roebuck, Ontario, it was found that in many cases a certain amount of dissimilarity existed between the right and left femora of the same individual. When paired femora were placed side by side on the same level, and with their condylar extremities together, it was found that their heads were on different levels, the right being usually the higher. This difference in the heights of the heads was due to a difference in the forward angles of the necks of the femora, that is, the angle between the neck of the femur and the horizontal. No twists or other abnormalities were observed in the shafts.

The deformity seems to have been very general among the inhabitants of this site. Of twenty-three pairs of adult femora examined, only three pairs were normal. The deformity is noticeable also among the bones of children, and even among infants so small that it is quite certain that they never walked. This would seem to prove that the deformity was congenital, and shows that it was certainly not the direct result of any habitual occupation.

Detailed examination has been made only in the case of adult skeletons. It shows that of twenty-one pairs of bones seventeen had the right deformed and six the left, two pairs having both bones deformed. In the case of the latter, the inclination of the necks was in opposite directions.

Although it has been asserted that the apparent hereditary nature of the deformity shows that it was not the direct result of habitual occupation of any sort, still habitual occupation may have been its primary cause. If it had been caused for generations by occupation it would ultimately, it may be presumed, be handed on by heredity; and thus a theoretical cause for the deformity may be found both in the case of adults and of children.

G. E. RHOADES
OTTAWA, CANADA

A CASE OF SUPERSENSITIVENESS TO THE POISONOUS ACTION OF THE CASTOR BEAN

THE frequency with which the castor bean seed is used in elementary courses in botany makes it seem advisable to record a case of supersensitiveness to the poisonous action of the castor bean plant which came under my observation.

The subject, Miss K., while taking the laboratory work in botany as a student developed a severe case of what appeared to be hay fever. It was apparently associated with something used in the laboratory. Not until a year later when she acted as an assistant in the same course was the castor bean found to be the cause.

The attacks were initiated with severe sneezing and some headache and general discomfort a few minutes after exposure. Her face became inflamed and puffy, eyes reddened and swelled, breathing was accompanied by a wheezy sensation. The mucous membranes were decidedly irritated and later cracked. The surface of the cornea of the eye in some cases became slightly wrinkled. After the heaviest attack

Miss K. was confined to her bed for three days, and the after-effects lasted for two weeks.

It was not necessary for her to handle the castor beans but merely to be in the room where they were dissected. In fact, in one instance a few beans were used in the laboratory in the morning from 10 to 12 when Miss K. was not present and was not aware of their being used. A few minutes after she came into the laboratory in the afternoon at one typical symptoms with sneezing and headache developed.

The castor bean plant had an effect similar to that of the bean. Within a few minutes after cutting the leaves and stems of a castor bean plant for histological purposes Miss K. suffered from a mild but typical attack.

Out of several hundred students the case mentioned is the only one of its type I have observed. It was noted, however, that one of the instructors suffered from a badly inflamed eye due to rubbing it with his fingers after dissecting some castor beans. Pammel, in discussing the castor oil bean in his manual of poisonous plants, states that "a case is known of a young lady whose eyes became inflamed when in contact with a mere trace of the material in the laboratory."

Effects from the castor bean similar to those described may be mistaken for colds or for attacks of hay fever produced by pollen.

WILLIAM J. ROBBINS
UNIVERSITY OF MISSOURI

QUOTATIONS

INDUSTRY AND CHEMICAL RESEARCH

WHY do clear-thinking, well-informed business men who hold the stock or compose the directorates of companies in our chemical engineering industries so frequently disparage a policy of research? An old riddle which is growing more perplexing as it ages! To regard a technical staff as a semi-liability at best, to dispense with it whenever storm clouds gather on the business horizon—such is altogether too frequently the creed of those who pass upon expenditures. No more clear-cut evidence of such folly, or rather the wisdom of the maintenance of research, has come to our attention recently than the remarkable story of achievement made by one of the great yeast companies. This story is at once an inspiration to the research worker and a rebuke to those whose first thought is to reduce the technical staff in time of financial difficulty.

A few years ago yeast was made by this particular company from a cereal mash on an enormous scale and in eleven plants. About one quarter of the grain was converted to yeast; from the mash alcoholic beverages and allied products were produced which yielded sufficient revenue to make possible a very low margin of profit on the yeast. Then came our entrance into the war. Edible cereals could no longer be used. Research found a manner of using oats as a substitute. Labor cost rose as high at 260 per cent. above the pre-war level. As an offset to this, research developed a process to increase the yield to a figure previously unheard of.

Then prohibition came, seemingly to cap the climax. Competition with industrial alcohol makers could not be met with the costly high-grade grain alcohol produced by this process. Yet without this market the cost of yeast must be substantially increased. Again after a real struggle on the part of the research staff in a comparatively unknown and poorly charted field of chemistry the answer was found—production from new materials with the evolution of no alcohol and of almost no other side products. The net result of its research, which was well paid for, enabled this company to maintain its retail prices at pre-war standards through years of rapidly shifting economic conditions. Its process reached an efficiency of practically 100 per cent. conversion of raw material to yeast. Its product was improved, its sales were increased, its research facilities developed to the highest point. And all this through a period when many firms were endeavoring to weather the storm by putting a sign over the laboratory door, "This Way Out."

We have cited other similar instances; we shall cite more. Research, despite the many kicks it has had, is alive and growing. Here is added justification for our contention that it is indispensable in trying as well as in prosperous periods. Properly directed, there is no better manner of insuring increased dividends.—*Chemical and Metallurgical Engineering.*

SCIENTIFIC BOOKS

Text-book of Agricultural Bacteriology. By F. LÖHNIS, Ph.D., U. S. Department of Agriculture, and E. B. FRED, Ph.D., University of Wisconsin. New York, McGraw-Hill Book Company, 1923, 283 pp., 10 plates, 66 illustrations in the text.

THIS work, as the authors indicate in their preface, is largely based upon the senior author's "Vorlesungen über landwirtschaftliche Bakteriologie," published in 1913, and representing the material collected during eleven years' experience in teaching and research at the University of Leipzig. It is, moreover, more than a translation of Löhnis's "Vorlesungen," representing a thorough revision and a rearrangement of the subject matter to make it more useful to the American and British reader.

Following an introduction which includes a survey of the history and scope of bacteriology, the authors pass to the main portion of the book which is divided

into two nearly equal parts: Part I—"General morphology and physiology of bacteria and related organisms" and Part II—"Dairy and soil bacteriology." Realizing more than most authors the importance of making the student of bacteriology acquainted with the fundamental principles of morphology and physiology before proceeding to the applied bacteriology of agriculture, the authors have wisely devoted half of their book to this important subject.

This ground has been thoroughly covered in a distinctive and unusually instructive fashion. The refreshing originality of the "Vorlesungen," in the opinion of the reviewer, lies in the fact that this work closely followed the form of the author's own lectures in agricultural bacteriology. In this new work the subject-matter is handled in essentially the same order, and although the actual subdivision into lectures has been somewhat changed, the original logical method and lucid style are preserved. The seven chapters of the first part deal with the fundamentals in such a way that the student is well prepared for the specialized parts that follow, and students of other branches of bacteriology than agricultural will find this half of the text-book well worthy of study. Not only are bacteria discussed, but related microorganisms, yeasts, fungi and protozoa are included in relation to their development and activities. Subjects dealt with include morphology, development, classification, relation to environment, methods of cultivation, control and physiological activities and relationships. The chapter on the activities of bacteria and related microorganisms, comprising some sixty pages, is specially thorough, and covers such subjects as the cycles of the elements in an unusually clear manner.

Part II deals with dairy and soil bacteriology. Following a chapter on the microbiology of foodstuffs are chapters on the relation of bacteria and other microorganisms to milk, butter, cheese, water and sewage, manure and soils. It might be objected that the important subjects of bacteria in relation to animal and plant diseases have not been covered. Both these fields, however, represent more or less distinct lines of scientific specialization, in distinction to that which is usually understood as agricultural bacteriology, and are related more properly to veterinary medicine and general plant pathology. The authors have mentioned their bearing to bacteriological physiology in Part I, but have, as indicated, reserved Part II for dairy and soil problems. To these seven chapters have been dedicated, and the authors, in considering the various subjects, have followed the uniform plan of discussing first germ content, then bacterial activities and following up with the practical application in each case.

Throughout the book adequate references on all essential points are made to the special literature of the subject, and in this regard the authors have included the most recent investigations. Special mention must be made of the illustrations in this text-book, almost all of which are original. These consist of 66 figures and 10 full-page plates, of which 7 are colored. For originality and excellence of reproduction these are the best we have seen in bacteriological literature, and add greatly to the value of the work, which is to be highly recommended for student use.

A. GRANT LOCHHEAD

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SPECIAL ARTICLES

A REMARKABLE DEVELOPMENT OF THE SPOROPHYTE IN ANTHOCEROS

THE genus Anthoceros is of special interest, as it more nearly approaches the Pteridophytes in the character of its sporophyte than does any other Bryophyte.

Of the American species of Anthoceros, *A. fusiformis* Aust., a very common species of the Pacific Coast, has much the longest sporophyte, which frequently reaches a length of two to three inches, or even more. The sporophytes are often produced in large numbers, so that a patch of fruiting plants looks like a tuft of fine grass.

The writer recently received from Dr. G. J. Peirce a number of specimens of *A. fusiformis* collected near Carmel, California, which showed a development of the sporophyte far exceeding anything hitherto recorded, so far as he is aware.

Some of these were full six inches (16 cm) in length, and were still actively growing. This is nearly twice the maximum length, 9 cm, recorded by Howe[1] for this species, and much exceeds anything seen by the writer in many years' collecting of Anthocerotaceae in various parts of the world.

Not only was there a remarkable increase in length, but the sporophytes were notably thicker than the normal ones.

Sections of some of these enlarged sporophytes showed that spore-formation had been almost completely suppressed in the basal region and the outer green tissue was much more extensive than in normal sporophytes. Still more striking was the greatly increased size of the central strand of tissue (columella), which might almost be denominated a simple vascular bundle.

The foot was also greatly enlarged and in two cases examined, the lower surface was almost completely exposed, and it is quite possible could absorb

[1] Howe, M. A., "The Anthocerotaceae of North America," *Bull.* Tor. Bot. Club, 24, p. 17, 1898.

water from below, without the intervention of the gametophytic tissues which had mostly withered. Indeed it looks as if these large sporophytes may have attained very nearly the complete independence characteristic of the Pteridophytes.

Usually *A. fusiformis* ripens its spores in the late spring, and both gametophyte and sporophyte dry up completely. The former, however, revives with the autumn rains. These large sporophytes were undoubtedly left over from last season and probably began to form some time in the autumn of 1922, as fertilization normally takes place within a short time after the first heavy rains, which last year fell early in October.

The writer visited the locality, San Jose Canyon, where these were collected. This is one of many small canyons south of Monterey, open to the ocean, so that they are invaded by the summer sea-fogs. There is a permanent stream, along whose banks fine redwoods, sycamores and alders were growing, as well as a rich growth of such liverworts as Fegatella and Marchantia, and several mosses.

The Anthoceros plants grew on low sandy banks, not far above the water level, and some of them showed fresh growth and bore a number of relatively young sporophytes.

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THE EFFECT OF THE REMOVAL OF THE MICRONUCLEUS

THE micronucleus in ciliates has commonly been considered to have solely a germinal function. In contrast with the macronucleus which, it is thought, serves for the upkeep of the individual, the micronucleus on the other hand is believed to provide exclusively for the maintenance of the race. This theory chiefly originates in applying to the *Ciliata* Weismann's hypothesis on the continuity of the germ plasm.

To ascertain the actual function of the micronucleus one must, of course, finally provide experimental means. This has been done by certain investigators (Balbiani, LeDantec, Lewin, *et al.*) who have removed the micronucleus from several ciliates, but this was accomplished by the excision of that part of the organism wherein the organelle lies. This method entails the burden of the regeneration of more or less of the organism and involves the possible removal of equally important stuffs.

The removal of the micronucleus from the freshwater ciliate, *Euplotes patella,* has been successfully accomplished in more than fifty specimens by means of a mercury micropipette without causing any additional injury except the loss of a meager amount of cytoplasm immediately surrounding the removed organelle. *Euplotes* so operated upon have never lived longer than five days nor have they divided more than twice, so far as could be observed. A number failed to divide at all and lived only two days. The average life is about three days. Specimens which were fixed and stained showed an absence of the micronucleus, hence it was not regenerated. Individual controls from which cytoplasm of various regions of the organism or portions of the macronucleus had been removed formed vigorous races.

The few earlier reports, especially of Lewin and LeDantec, of ciliates having formed thriving races or having regenerated the micronucleus, after the experimental removal of this organelle, have not been substantiated by any of the experimental work done within the past dozen years. Several races of different species of ciliates have recently been intensively studied (Woodruff) and found to exhibit no morphological micronucleus. These races thrive apparently indefinitely. Conjugation either is not attempted or the conjugants always die. Two of these races have been known to arise from a micronucleate race which did conjugate normally. Woodruff (1921) has suggested that the macro- and micro-nucleus may have formed together in such races an "amphinucleus," which would be adequate for all life phenomena, but which would not permit the germinal chromatin in the micronucleus to become available for conjugation and endomixis. A morphological micronucleus would, accordingly, not be necessary for the vegetative life of the organism. The occurrence of such a nuclear change, however, is as yet not established.

If the micronucleus is solely germinal in function, it would be expected that a ciliate with no other injury than the loss of this organelle would give rise to a race asexually. The evidence from experiments on *Euplotes patella* goes to show that it can not continue to live and divide without the micronucleus. Just what rôle further than germinal the micronucleus plays is problematical. Hertwig, Calkins and others have maintained that the nucleus gives off certain formative substances, perhaps like enzymes, which are exhausted during cell-division. The results of the experiments thus far carried out on *Euplotes* suggest that the micronucleus performs some such rôle in the economy of this ciliate. The amount of the hypothetical substance present in the cytoplasm at the time of the removal of the micronucleus would determine the number of divisions possible before death. Division being impossible, death might ensue from a condition comparable to senescence in the metazoan cell or possibly from a surfeit of food which would normally be relieved by division.

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THE AMERICAN CHEMICAL SOCIETY

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Robert E. Wilson, *chairman*
Graham Edgar, *secretary*

The use of radon in studying radio-chemical problems: S. C. LIND.

The determination by a chemical method of the mean effective path of alpha-particles in small spheres: S. C. LIND and D. C. BARDWELL. The mean linear path of alpha-particles in a gas contained in a sphere depends on the point of origin of the particle. If from the wall, it is 0.5 × the radius of the sphere; if from the gas itself, it is 0.75 × the radius. In order to determine the exact value under the experimental conditions in gas reactions, two series of measurements were made of the rate of combination of electrolytic hydrogen and oxygen: (1) with radon confined at the center of the reaction sphere, (2) with it mixed with the gases. The ratio of the velocity in (2) to that in (1) is, after suitable correction, that fraction of r sought. The value obtained is 0.61 × r. A possible interpretation in terms of diffusion of active deposit is presented.

Revision of the chemical effect of recoil atoms: S. C. LIND and D. C. BARDWELL. The experiments on the effect of recoil atoms in contributing to the chemical effects of radon in hydrogen and oxygen electrolytic mixture have been repeated under somewhat more favorable conditions than those originally employed in part II. The results confirm the earlier experimental ones satisfactorily. Certain apparent discrepancies between the inverse square of the diameter law and the recoil atom effect are removed.

Oxidation, reduction and decomposition of the oxides of carbon: S. C. LIND and D. C. BARDWELL. The rate of the following gas reactions have been studied kinetically when produced at ordinary temperature by radon: The decomposition of CO and of CO_2 (no reaction); oxidation of CO by O_2; reduction of CO and of CO_2 by H_2. All of the rates are relatively rapid except that of decomposition of CO_2. The M/N values are mainly those to be expected on the theory of active gas ions forming addition products with one or two neutral molecules. The theory is advanced that the CO_2 ion reacts with neutral CO_2 to form an addition product (just as in the case of CO), but that this complex again decomposes into CO_2, giving no resultant reaction. This is supported by the evidence obtained by introducing H_2 as an acceptor for the CO_2 ions which is found to lead to rapid reduction of CO_2. It is shown that it is not merely a matter of the action of active hydrogen on neutral CO_2. The products of all the reactions have been analyzed, but owing to the small quantities of gases being dealt with, some of the results are not yet regarded as final.

A method for photographing the disintegration of atoms, and photographs of single and double atomic collisions, and a new type of rays: WILLIAM D. HARKINS and R. W. RYAN. In the collision of an alpha particle or helium nucleus with the nucleus of an atom of air three tracks are seen to radiate from a point. If a fourth track is present it represents either (1) the disintegration of the bombarded nucleus, or (2) a double collision. In a simple collision momentum is conserved, and all of the tracks lie in one plane. In a disintegration or a double collision momentum should be conserved if all of the tracks are considered, but, unless by accident, all of the tracks will not be coplanar. By taking 41,000 photographs of alpha ray tracks in air, argon and other gases the writers have obtained two photographs which represent either double collisions, a very improbable event, or an atomic disintegration. One of these was obtained in air, the other in argon. The photograph in argon gives the appearance to be expected if the helium nucleus first hit an argon nucleus and the argon nucleus, within a distance of ½ mm, hit a second argon nucleus. A double collision of this kind is very much more improbable in air than in argon, and the photograph secured in air seems to indicate that a double collision did not occur. A new kind of rays, called zeta rays, have been found.

Reactions in phosgene solution. I: ALBERT F. O. GERMANN. Liquid $COCl_2$ does not react with metals nor is it in general a solvent for metallic salts (Beckmann and Junker). It dissolves $AlCl_3$ readily, forming phosgenates (Baud). Potassium, distilled in vacuo, covered with liquid $COCl_2$, shows no tarnish after a year; this is typical of the inactivity of the metals towards this solvent. However, covered with $COCl_2$ and exposed to the sunlight in ordinary soft glass tubes, potassium becomes coated with a violet deposit, which has the appearance of finely divided potassium; copper and zinc are corroded; and aluminium dissolves as $AlCl_3$, producing a yellow solution, which soon develops enough color to stop the reaction by absorbing the active wave lengths; in each case a gas (carbon monoxide) is evolved during isolation; magnesium is not attacked. Amalgamation makes Al active towards liquid phosgene, but has no effect in the case of Zn and Cu, whose chlorides are insoluble. Chlorine dissolved in $COCl_2$ attacks Al and Hg, but does not attack Mg. $COCl_2$ containing dissolved $AlCl_3$ attacks potassium, producing a rather voluminous precipitate and evolving a gas. The behavior of $COCl_2$ towards the metals in the presence of $AlCl_3$ is so unusual that this type of reactions has been given special study, the results of which are presented in another paper. Liquid $COCl_2$ converts KI into KCl and I_2, crystals of iodine separating from the solution as the reaction proceeds; CNI is more slowly decomposed; the usefulness of $KI + Na_2S_2O_3$ to separate Cl_2 from $COCl_2$ is thus brought into question.

Reactions in phosgene solution. II. The reaction of calcium with phosgene: ALBERT F. O. GERMANN and KENNETH A. GAGOS. It has been shown that, while metals in general do not react with $COCl_2$, a reaction may take place in the presence of $AlCl_3$, which is very soluble. In a preliminary survey, magnesium, calcium, zinc and cadmium, as well as potassium (as indicated in a previous paper) were found to yield a gas, shown to be carbon monoxide, with $COCl_2$ in the presence of $AlCl_3$. The compound with magnesium is liquid at ordinary temperatures, becomes very viscous when cooled, and yields a two layer system with $COCl_2$. This compound is under investigation. The compound with cadmium is

solid, and appears to be very soluble, but the reaction is slow; other methods of preparing it are being worked out. Calcium and magnesium react with great readiness, so that the reaction comes to completion in a relatively short time. It was found that the amount of action was proportional to the amount of $AlCl_3$ present, provided metal and $COCl_2$ are in excess. By saturating solutions containing weighed amounts of $AlCl_3$, and dephosgenating the salt formed, residues of constant composition were formed, whose analysis led to the formula $CaCl_2.2AlCl_3$. Vapor tension-composition measurements at 19.5° C. showed that the crystals separating from the solution contain two molecules of phosgene, so that their formula is $CaCl_2.2AlCl_3.2COCl_2$. The vapor tension of the compound at this temperature is about 25 mm.

The critical temperature and pressure of phosgene: ALBERT F. O. GERMANN and QUIMBY W. TAYLOR. Measurements have been made of the critical temperature of $COCl_2$, but as far as we are aware, the critical pressure has not been measured. The $COCl_2$ used in this investigation was a technical sample obtained from the Chemical Warfare Service, and was purified by passing the gas over the usual absorbents for impurities, and by repeated fractional distillation under diminished pressure, until the vapor pressure at zero became constant. It was found impossible to prepare pure $COCl_2$ in this way (see also SCIENCE, 57, 564), as not one sample examined showed monovariance when liquefied at higher temperatures. The value obtained for the critical pressure, $Pc = 65$ atm., is therefore probably somewhat too high. The value obtained for the critical temperature, $Tc = 273 + 182$, is one degree below that obtained by Hackspill and Mathieu, and five degrees below that obtained by Paterno and Mazzuchelli.

The measurement of the heat of adsorption of gases by catalysts: R. A. BEEBE and H. S. TAYLOR. A method has been devised for the direct measurement of heats of adsorption. It consists in determining the temperature rise produced in the mass of a given catalyst when the gas to be studied is introduced into the system. The catalyst material is contained in a special vacuum vessel to facilitate thermal insulation. The heat capacity of the system is determined by liberating into the system a measured amount of electrical energy, using a resistance wire distributed throughout, but insulated from, the catalyst. The heats of adsorption of hydrogen on nickel and on copper have been determined as 14,000–20,000 calories and 9,600 calories respectively per mol of adsorbed gas. These values are markedly higher than the heat of vaporization (450 calories approx.). The measurements are being extended to other gases, other catalysts, and other preparations of the above catalysts, since the values obtained depend in part on the characteristics of the adsorbant.

Studies on solubility. The ideal activity coefficient of strong electrolytes in the presence of mixed electrolytes: J. N. BRÖNSTED and V. K. LAMER.

Overvoltage: WILLIAM D. HARKINS and H. S. ADAMS. The hydrogen overvoltage of mercury is found to be a linear function of the logarithm of the current density over a very extensive range if the cathode is carefully prepolarized; it decreases 2 millivolts per degree of rise of temperature, and remains constant as the pressure is varied between 14 and 2,300 mm. Stirring the electrolyte by a stirrer or by bubbling gas through it decreases the overvoltage of a number of metals, especially for those of high overvoltages at low current densities. A superimposed alternating current lowers the overvoltage in most cases but increases that of copper except at very low current densities, whether the copper is smooth or rough. The overvoltage of 12 metals at 25 degrees was determined over a considerable range of current density. In agreement with the early observations of Harkins overvoltage is found to be related to the position of the element in the periodic system. Rough cathodes were found to give lower overvoltages than smooth ones. Overvoltage increases with time.

Two types of overvoltage: L. J. BIRCHER, WILLIAM D. HARKINS and GERHARD DIETRICHSON. Opposite opinions concerning the characteristics of overvoltage have arisen through the failure to recognize that there are overvoltages of two types. What we will designate as type A overvoltage is peculiar to active metals, has a positive temperature coefficient and its value corresponds closely to the single potential exhibited by the metal. This type of overvoltage persists in certain instances even though the current density is quite high. Certain recent investigations have given incorrect indications as to the characteristics of ordinary overvoltage by carrying out the work in a range in which overvoltage of type A is partly in effect. Ordinary or type B overvoltage has a negative temperature coefficient which for the current densities investigated, is 2 mv per degree for mercury, gold and copper; so thus far it has been found to be independent of the metal.

Effect of pressure upon overvoltage: In 1914 Harkins and Adams found that the hydrogen overvoltage of mercury remains practically constant between 14 and 2,300 mm, and Newbury found oxygen overvoltage to be constant between 1 and 100 atmospheres. Later work by other investigators indicates that on the contrary hydrogen overvoltage, at least for mercury, lead and nickel, increases with extreme rapidity as the pressure is lowered below 300 mm. The present investigation shows that the apparent great increase is fictitious, and is probably due to the failure of the comparison hydrogen electrode, used also as an anode, to function properly at low pressures. The present work indicates that in the cases of mercury, lead, and nickel at least, the potential of the cathode remains constant as the pressure is lowered to 11 mm, so the increase of overvoltage is very slight, being equal only to the small decrease of the potential of the hydrogen electrode. These results were obtained by using the mercurous sulphate electrode, instead of the hydrogen electrode, as the direct standard of reference, and by a comparison of the hydrogen and mercurous sulphate electrodes at different pressures.

Adsorption by precipitates VI; the adsorption of precipitating ions from mixtures of electrolytes: HARRY B. WEISER. The precipitation value for colloids of mixtures of electrolytes is influenced by the so-called antagonistic action of the precipitating ions and by the stabilizing

action of the ions having the same charge as the colloid. In cases where the influence of the stabilizing ion is slight, the precipitation values of mixtures show an approximately additive relationship since the antagonistic action of ions even of varying valence is not so marked as usually supposed in the region below the precipitation concentration of each. On the contrary, the antagonistic action is frequently so slight that the precipitating effect of mixtures of ions of the same or varying valence is less instead of greater than the additive value because of relatively greater adsorption of each at concentrations considerably below their precipitation value. Investigations on the hydrous oxides of iron, chromium and tin with precipitating ions showing a wide variation in their degree of hydration, disprove Freundlich's view that the hydration of a colloid and of the precipitating ions determines whether coagulation takes place at a higher concentration with mixtures than with a single electrolyte. The precipitation value of mixtures is higher than that of a single electrolyte in case an ion having the same charge as the colloid is so strongly adsorbed within certain concentrations that it opposes the action of the precipitating ions.

Adsorption of dyes by gels under a varying pH: R. E. MARKER and NEIL E. GORDON. Solutions of acid and basic dyes of a varying hydrogen ion concentration were shaken with silica, alumina and ferric oxide gels until equilibrium was established. The adsorption of dyes was then determined when it was found that the amount adsorbed by the ferric oxide and alumina gel in most cases was a function of the hydrogen ion concentration, while the change of adsorption with hydrogen ion was small in most cases with the silica gel.

Adsorption of dyes by gels under a varying pH in the presence of inorganic salts: C. E. WHITE and NEIL E. GORDON. The adsorption of acid and basic dyes was tried with silica, alumina and ferric oxide gels, while the hydrogen ion was changed within such limits as were possible under the conditions of the experiment, and while some inorganic salts of a definite concentration (usual .05N) was present. The inorganic salts cut down the adsorption in most cases.

Adsorption by activated sugar charcoal: ELROY J. MILLER. Evidence is presented to prove that adsorption of electrolytes from solution is accompanied by hydrolysis. Solutions of a number of salts when treated with pure, ash and nitrogen-free, activated sugar charcoal became alkaline, indicating that some hydrolysis had taken place with subsequent adsorption of the acid. By suitable means these adsorbed acids were recovered from the charcoal, identified and found to be equivalent in amount to the bases set free. This is in accord with the results obtained by Bartell and Miller (*J. Amer. Chem.* Soc., 44, 1966 [1922], 45, 1106 [1923]) and in disagreement with the views of Michaelis and Rona (*Biochem. Zeit.*, 97, 57 [1919]), and Odén and Anderson (*J. Phys. Chem.*, 25, 311 [1921]), who maintain that hydrolytic adsorption does not take place.

Adsorption of inorganic salts by alumina gel under a varying hydrogen ion concentration: E. B. STARKEY and NEIL E. GORDON. .05N solutions of potassium nitrate, potassium sulfate, potassium acid phosphate and the same salts of calcium, each having a varying hydrogen-ion concentration, were shaken with alumina gel until equilibrium was established. The adsorption of the different ions was determined. It was found that the hydrogen-ion concentration had marked effect on the amount of adsorption of the respective radicals.

The rôle of hydrogen ion concentration in the precipitation of colloids: H. V. TARTAR. A study has been made of the effect of hydrogen-ion concentration (pH) on the precipitation of mastic, gamboge, arsenious sulfide and aluminium hydroxide with electrolytes. Each of the negatively charged colloids is precipitated by acids at a given hydrogen-ion concentration regardless of the concentration of the sol. Different bases precipitate aluminium hydroxide sols of varying concentrations at the same pH. With salts, equal concentrations of ions of the valence are required to precipitate a given sol at the same pH and in nearly all cases the ion bearing a charge similar to that of the colloid particle is without effect. The efficiency of ions in precipitation is not absolute but must be considered with reference to the hydrogen-ion concentration.

Effect of light and H-ion concentration on the formation of colloidal gold in silicic acid gel. Rhythmic bands of purple of Cassius: EARL C. H. DAVIES. Experiments show that with silicic acid, gold chloride gels some remarkable effects of light are evident and that it is the light of short wave lengths which functions, if H_2SO_4 is present. The experiments remove W. D. Bancroft's objection to H. H. Holmes' diffusion theory of Liesegang band formation. A series of experiments shows that there is a distinct relation between H-ion concentration and the size of the "pockets" in which the gold is formed. A striking lecture experiment shows the influence of light on reduction. Purple of Cassius was obtained in true Liesegang bands.

The effect of hydrophillic colloids on the size and distribution of particles in electrolytic precipitation. I. Gelatin and basic lead carbonate: DORMAN MCBURNEY and W. G. FRANCE. The analogy between the effect of gelatin on the character of the deposit in the electrodeposition of metals and the electro-precipitation of salts is suggested. The effect of gelatin on the size and distribution of particles in the electro-precipitation of basic lead carbonate at $20° + 1°$ was studied. Photomicrographs of the product were taken and the size and distribution of particles determined by the method of Green. The data indicate that the presence of gelatin in concentrations from 0.013 per cent. to 1 per cent. is accompanied by a marked decrease in the average size of the particles of basic lead carbonate. A product of much greater uniformity in particle size is obtained in the presence of gelatin than in its absence.

Sol stability under centrifugation: W. G. FRANCE. The relative stability of a number of sols under centrifugation has been determined by observing the time required for the precipitation when definite volumes of sols are acted upon by known centrifugal forces. The sols investigated were $Fe(OH)_3$; Sb_2S_3; gold prepared by three different methods; and an ethyl alcohol gold sol

prepared by the Bredig method. The decreasing order of relative stability was found to be $Fe(OH)_3$; Sb_2S_3; gold by Bredig method; gold by Tannin reduction; gold by formaldehyde reduction; and gold ethyl alcohol sol by Bredig method. It was further observed that, on standing after precipitation, the precipitated phase gradually diffused back into the dispersion medium in all cases except that of the ethyl alcohol, provided that centrifugation had not been carried on too long after precipitation. It is suggested that the stability may in part be accounted for on the assumption that a protective action is exerted by adsorbed films of the dispersion media, the nature of which are influenced by the methods of preparation of the sols.

A theory of emulsions and the inversion of emulsions: WILLIAM D. HARKINS. In 1917 the writer proposed a theory according to which the stability of emulsions, of the type produced by soaps, is dependent upon the existence, around the droplets, of a film of molecules, with the polar ends oriented toward the water, and the non-polar end toward the oil. A second, and independent, part of the theory considered the molecules as capable of representation as the frustra of cones (or in a plane as wedges). With sodium oleate drops of oil form inside the water. By a change from sodium to magnesium or calcium oleate the cross section of the polar or water-like end of the molecule is not greatly changed, but the substitution of two paraffin hydrocarbon chains for one increases the cross-section of the non-polar or oil-like end by about 42 per cent. Thus the polar end of the molecule becomes the smaller end of the frustrum; so the emulsion is inverted and the water drops become the inside phase. Naturally the size of the polar end of the molecule is also of importance. The paper will present evidence in favor of the theory.

A method for the study of rapid adsorption of gases in liquids: P. G. LEDIG and H. E. WEAVER. An apparatus is described which gives a photographic record of the course of absorption of a CO_2 bubble in a stream of hydroxide solution. From this photographic record the rate of absorption over the period of the absorption can be determined. A number of figures are presented showing the effect of concentration, bubble volume and other variables upon the rate of absorption.

The free energy of mercurides: ROSCOE H. GERKE. Alloys and metallic compounds are important classes of substances for which there are few free energy data. It is the purpose of this paper to collect available data on metallic compounds and solid solutions containing mercury, and, incidentally, point out that the method of calculating these quantities involves the use of partial molal free energy. Hitherto, the concept of partial molal free energy has not been used to split up the free energy of formation of a compound from its constituent elements into two parts, as has been done in this paper. In the case of the mercurides, and other metallic compounds, it will be seen that the free energy of formation of the compound from its elements is equal to the sum of the separate free energy changes which the elements undergo in the formation of the compound.

The conventions have been such that the free energy of formation, ΔF (25 degrees) $= -18{,}351$ calories, means that there has been a decrease at 25 degrees and 1 atm. of free energy attending the formation of one mol of $NaHg_5$ from one atom of Na and 5 atoms of Hg. This decrease has been divided between the decrease for the sodium and the mercury respectively, such that $\bar{F}_2$ equals $-18{,}046$ calories and $\bar{F}_1$ equals 61 calories per atom. It is to be noted that the more electropositive the metal, the greater is the free energy change, except for the case of lithium.

The most striking and unexpected conclusion which can be drawn from these data is that the mercury does not greatly change in free energy, when it enters into chemical combination with a more electropositive metal. In other words, the vapor pressure of pure liquid mercury is only very slightly greater than the partial pressure of mercury from an amalgam saturated with a mercuride. On the other hand, the electropositive metal decreases in free energy more than the mercury in the formation of the compounds.

Although the free energy of other metallic compounds and also compounds of the type represented by iodine chloride can be calculated by the above method, it does not seem feasible to make similar measurements for a simple compound such as sodium chloride, since it is not possible to have solid sodium chloride in equilibrium with its solution of sodium in liquid chlorine.

In conclusion, it may be stated that, if mercury reacts with a more electropositive metal to form a mercuride, the change in free energy for the mercury is small compared with that of the more electropositive metal.

A relation between energy of reaction between atoms and electron affinity of electronegative atoms: ROSCOE H. GERKE. The energy of formation of halides from monoatomic elements in the gaseous state has been found to give an approximately constant value. In the case of KCl, NaCl, HCl, TlCl and AgCl, the values are respectively, 124.4, 115.3, 109.5, 108.3, 98.0 Kg. cal. The average energy of formation is 111.1 Kg. cal., which is in close agreement with the value, 111.0 Kg. cal., for the electron affinity of chlorine. In the case of bromides and iodides the agreement is not so close. These rough agreements seem to indicate that the energetics for these simple chemical reactions are accounted for by the differences in energy level of electrons in the atoms before and after the reaction. Also, the order of electropositive elements in the electromotive series seems to be governed by the heats of evaporation of the electropositive elements and the heats of sublimation of their compounds.

Relations involving the disintegration of atoms: WILLIAM D. HARKINS. The paper shows that the work of Rutherford on the disintegration of light atoms directly confirms the first definite theory of the composition of the light atoms, that of Harkins and Wilson. Thus, atoms in which the hydrogen is bound in the form of alpha particles have in no case given off hydrogen when bombarded by swift alpha particles. Also atoms in which the theory indicates that the part or parts of the nucleus which contains hydrogen not bound into alpha particles has the formula *pe* or $(pe)_2$, have not disintegrated to give long range hydrogen particles. Thus, as

indicated by one of the corollaries of the theory proposed by Harkins, hydrogen is found to be in unstable combination only when the part of the nucleus which does not consist of alpha particles contains more protons than electrons. This correspondence between the experimental facts and the theory was noticed independently by Fajans and the writer.

Characteristics of the alpha-ray bulb as a source of ionization: D. C. BARDWELL and H. A. DOERNER. For the corrections involved in Part III, a knowledge of the characteristics of the alpha-ray bulb as a radiator, as affected by the tip and neck, by the thickness of the wall and obliquity of passage of alpha-particles through it, and by the diameter of the bulb (reducing it to zero dimensions in order to afford radiation from a point source) is necessary. In addition, the other corrections applying to the outer sphere itself are treated, such as the dead-arm correction and the change of ionization intensity with the pressure. The recoil atom effect as revised in paper V is also used as a correction for the results, to reduce them to the same conditions as those obtaining outside the alpha-ray bulb, through which recoil atoms cannot penetrate.

A study of the factors influencing the velocity of crystallization (V. C.) of substances from supersaturated solutions: JOHN D. JENKINS and JAMES H. WALTON. An apparatus for the determination of very rapid crystallizations by following the process with a dipping refractometer immersed directly in the crystallizing solution has been devised and described, and a large number of runs made to determine the effect of the addition of various substances upon the V. C. of naphthalene and urea from their solutions in methyl alcohol. The results of those runs have been tabulated. The ability of a substance to affect the V. C. seems to be a very specific property. A thermometric method of measuring the V. C. of substances in various solvents has also been worked out and the apparatus and method described. It consists in inoculating a supersaturated solution with a known weight of standard seed crystals and measuring the rate of rise of temperature of the rapidly stirred solution in a thermally isolated cell. The constants are calculated from the curve this obtained after correction for radiation and heating due to the stirring of the solution.

Measurements of the V. C. of three solutes, urea, acetanilid and ammonium nitrate have been made by this method in various solvents and mixtures. The results of this investigation show that the important factor in the V. C. of these substances from such solvents and mixtures is the viscosity of the medium. The relation between the velocity constant, K, and viscosity is given by the equation—$KS = A/\eta$, where $0.57 - \eta$ is the viscosity of the solution, A is an arbitrary constant depending upon the solute, and S is the surface area of the crystals per unit volume of solution. The results of these experiments have been discussed in relation to some of the present theories and the inadequacies of some of these pointed out. Berthoud's formula—$dc/dt = (DS)/(\delta + D/K)(C_0 - C)$—was shown to fit the facts better than any of the others. The temperature coefficient of the V. C. of acetanilid in several solvents has been determined and found to be due only to the decrease in viscosity of the medium at the higher temperature.

Heterogeneous Catalysis. I. The selective action of catalytic nickel in the hydrogenation of certain vegetable oils: A. S. RICHARDSON, C. A. KNUTH and C. H. MILLIGAN. The previous literature on selective hydrogenation is reviewed, and new data are presented to show that the hydrogenation of cottonseed, peanut and soya bean oils with use of nicked catalyst is characterized by the preferential conversion of linolic acid to oleic acid and its isomers. The selective character of the hydrogenation of these oils appears to be more marked with use of increasing amounts of catalyst and with increasing temperature up to an optimum in the neighborhood of 200 degrees C. The experimental results favor the view that intermediate adsorption compounds are formed between catalyst and unsaturated components. The nature of these adsorption compounds is discussed.

The catalytic activity of certain metals prepared by the reducing action of adsorbed hydrogen: L. H. REYERSON and KIRK THOMAS. Hydrogen, adsorbed by porous substances such as silica gel, reduced to the metallic state ions of the following metals, silver, gold, copper, platinum and palladium. Of these platinum, palladium and copper, supported by the silica gel, showed marked activity as catalysts in hydrogenation. At 0 degrees C. the palladium catalyst converted 95 per cent. of the ethylene used to ethane. At the same temperature the platinum catalyst converted 65 per cent. of the ethylene and at room temperature the copper catalyst converted 5 per cent. of the ethylene. These values represent averages, and they were obtained on passing the mixed gases through the catalyst once at a moderate rate.

Concerning zinc perchlorate: D. L. RANDALL. This salt, which was first mentioned by Serullas in 1831, has been little described in the literature. It was prepared by treating zinc carbonate with perchloric acid. On evaporation and cooling in a desiccator over fused calcium chlorid long needle-like crystals were formed. On analysis the results indicated the formation of the hexahydrate. The salt which is very soluble will deliquesce in a moist atmosphere but in a dry atmosphere will return to its crystalline form.

A further study of the sulfides and selenides of ammonium: A. S. KING and C. R. MCCROSKY.

Fluosilicic acid III, titration and properties: C. JACOBSON. Schucht and Möller's (ber. 39, 3693, 1906) method has been improved. The acid is titrated with normal NaOH in two stages, by first adding an excess of a neutral salt like NaCl. The first stage titration takes place at five degrees or below, in concentrated solution, using methyl orange as indicator and may be represented by the following equations: $H_2SiF_6 + 2NaCl = Na_2SiF_6 + 2HCl$, $2HCl + 2NaOH = 2NaCl + 2H_2O$. The second stage titration serves as a check upon the first and is represented as follows: $Na_2SiF_6 + 4NaOH = 6NaF + H_4SiO_4$. The results are consistent and satisfactory. The properties such as specific gravity, index of refraction, odor, taste, stability, chemical activity, etc., of a 60 per cent. solution of fluosilicic acid have been recorded.

Solubilities of yttrium salts: B. S. HOPKINS, M. C.

CREW and HILDUR E. STEINERT. The salts used were prepared from the yttrium material purified in the investigation which gave the present accepted atomic weight value of yttrium. A saturated solution was prepared in a thermostat, definite portions withdrawn and the solution weighed in a crucible inclosed in glass stoppered weighing bottle. The amount of yttrium oxide was determined by igniting to the oxide and weighing. From these values the amount of anhydrous yttrium salt in solution in 100 grams of water was calculated. Values were obtained for the chloride, bromide, nitrate and sulfate of yttrium at temperatures ranging from 0 degrees to 95 degrees. The curves were all regular, showing for the chloride a slight increase of solubility with rise of temperature; for the bromide and nitrate somewhat greater increase in solubility and for the sulfate a regular decrease in solubility with rise of temperature. Dilatometer tests showed no change in hydration within the temperatures used.

Electrometric titration of iodate, bromate, chlorate, ferricyanide with titanous salt: W. S. HENDRIXSON. The results show that the halogen oxy-acids can be accurately determined at room temperature, and stopping at the end points; that is, without adding an excess of titanium and titrating back with another oxidizing agent. In the presence of sulfuric acid iodate and bromate show two sharp falls in potential, the first marking the complete destruction of the oxidizing acid and the second the reduction of the free halogen. All these acids give large, sharp rises in potential on adding a few drops of titanous solution at the beginning of the titrations.

The influence of gelatin on the transference numbers of hydrochloric acid: W. H. MORAN and W. G. FRANCE. The transference numbers were measured by the concentration cell method using M/10 and M/100 HCl at 25 degrees. The value for the anion was found to be 0.1699. The addition of gelatin over a concentration range of 0 to 20 per cent. resulted in a change in the value of the anion transference number from 0.1699 to 0.7772. Conductivity measurements of M/10 and M/100 HCl were made over the same gelatin concentration range. In both cases the conductivity was so reduced as to indicate that HCl was removed as a whole from the solutions by the gelatin. The results obtained are in agreement with the prediction previously made by one of us in collaboration with A. L. Ferguson (A. L. Ferguson and W. G. France, *J. Am. Chem. Soc.*, 43, 2161, 1921), in which it was stated that in acids the presence of the gelatin would result in an increase in the transference number of the anion.

The setting of plaster of Paris and its acceleration: HARVEY A. NEVILLE. The setting of plaster of Paris is accelerated by solutions of inorganic compounds and retarded by certain organic substances. The explanation of this as due to the increase (or decrease) in the solubility of $CaSO_4$ by the dissolved substance is unsatisfactory. The acceleration may be considered an example of "catalysis in hydration." The stages in the setting of plaster of Paris are apparently: (1) Absorption by the plaster of all the water in amounts up to four times its weight. A stiff gel is formed and a very slight temperature effect is noted; (2) the gel breaks to form gypsum and free water, most of which gradually evaporates from the pores. Considerable heat is evolved in this stage due to the reaction: $CaSo_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O +$ 3900 calories. Both the formation and the breaking of the gel are accelerated by inorganic compounds. The retarders act as protective colloids.

Chloroform hydrate and its transition point: ARTHUR E. HILL. The existence of the compound $CHCl_3.18H_2O$, discovered by Chancel and Parmentier, has been confirmed. The compound can be formed by cooling the two components until ice appears, at —0.1 degree; in the absence of ice no compound is formed even on long contact. It is formed only at the interface between chloroform and water, and can not be obtained from either of the saturated liquids alone; the rate of formation is very low. In order to purify it for analysis, it is placed in a desiccator over ice, and maintained at 0 degrees or below; the excess liquid evaporates, forms compound on the ice in the lower part of the desiccator and leaves the stable system, compound-ice-vapor. The compound has a transition temperature into the two nearly insoluble liquids, chloroform and water, at + 1.45 degrees. On warming, however, it shows suspended transformation into the liquids, and may be heated at least as high as 6 degrees before total disappearance. The possibility of superheating depends upon the slowness with which equilibrium is attained in the liquid state, the reactions being first the dissociation of fused compound into its components and second the separation of the liquid into two liquid layers. The phase-rule diagram shows that the compound must possess a metastable congruent melting-point which falls within the two-liquid area. Suspended transformation in a system of this character has not previously been noticed.

The rôle of pectin in gel formation: HARRY N. HOLMES and HARRIET A. HOWE. It seems probable that partial dehydration of hydrated pectin explains the formation of fruit jellies. The sugar acts as a dehydrating agent and the hydrogen ions are probably adsorbed with an influence on hydration. Alcohols take up part of the water from a pectin solution with formation of gels. Glacial acetic acid also takes up water from a pectin solution with formation of gels. So does the proper concentration of phosphoric acid and of hydrochloric acid and of sulfuric acid. A one per cent. solution of pure pectin in hot 0.1 N NaOH gels on standing. Perhaps pectin is a weak acid and forms sodium pectate, well hydrated. Ammonium and barium pectates have similar properties. Barium chloride solutions produce no gels with pectin solution but if a sodium pectate is first formed addition of any soluble salt forms a gel. So does direct addition of barium hydroxide to a pectin solution.

Gel structure: WILLIAM C. ARSEM. The viewpoint presented is that a gel is an intimate mixture of two phases, one solid and the other liquid. The solid phase is pseudo-crystalline. It forms a molecular lattice which differs from a perfect crystalline lattice in that it is greatly expanded and the atoms are not connected at all possible points. A large proportion of the auxiliary

valences are not brought into play except as they may function in holding molecules of the liquid phase. There are thus a great many voids of approximately molecular dimensions which are filled with the liquid phase. A discussion is given of the mutual relations of the sol, gel and crystal states and the conditions for their formation, together with explanations of some colloid phenomena such as swelling and syneresis.

Films: benzene derivatives: WILLIAM D. HARKINS and ELVAH GRAFTON. On account of the fact that the structure of benzene is unknown and since compounds of benzene are in general much more difficult to work with in films on water than the derivatives of the paraffins, practically no experimental work has been done with benzene derivatives. Using as a basis the orientation theory of surfaces, and the plane formula of benzene, Harkins, Davies and Clark in 1917 considered that the area per molecule should increase in the order pyrocatechol, resorcinol and hydroquinone. This is here confirmed experimentally. The area per molecule in square Angstrom units is found to be phenol, 36.6, pyrogallol, 42.7; pyrocatechol, 55.3; resorcinol, 96; hydroquinone (185). The value for hydroquinol is not comparable with the others, since the molecules in the film were not in contact. The surface polarity of these compounds increases in the order; phenol, pyrocatechol, resorcinol, pyrogallol and hydroquinol, and thus increases as the distance between the hydroxyl groups around the ring in the plane formula.

Preparation of manganates and permanganates in liquid ammonia and water systems: H. B. SIEMS.

A method of determination of the solubility of hydrocarbons in water and the solubility of a few cyclic hydrocarbons at 25° C.: ERNEST BATEMAN and CARLETON HENNINGSEN. A method is described for determining the solubility of hydrocarbons in water with an accuracy of at least ± 5 per cent. The method consists essentially of aeration of the saturation solution at elevated temperatures and passing the air and hydrocarbon through a combustion furnace. The solubility of a few cyclic hydrocarbons in water at 25° C. is given as follows: Benzene, 0.190 gms; cyclohexene, 0.020 gms; cyclohexane, 0.0050 gms; toluene, 0.057 gms; mesitylene, 0.0056 gms; durene, 0.0015 gms; and diphenyl, 0.00041 gms per 100 cc solution.

The solubility of some amino and nitro derivatives of benzene in water at 25° C.: ERNEST BATEMAN and ROY BAECHLER. The paper shows that nitro derivatives of benzene can be reduced to amino compounds up to the limit of their solubility in water. The amino group can then be determined by the usual Kjeldahl method. The solubility in water at 25° C. for nitrobenzene, m-dinitrobenzene, sym-trinitrobenzene, o-nitrochlorbenzene, p-nitrotoluene, o-nitrophenol, p-nitrophenol, o-aminophenol, p-chloraniline and m-nitroaniline are given.

The autoxidation of hydroquinone and the stability of the quinhydrone electrode: V. K. LAMER and ERIC K. RIDEAL.

Studies in photographic sensitivity III. Effect of oxidizers on the sensitivity and on the latent image: E. P. WIGHTMAN, A. P. H. TRIVELLI, S. E. SHEPPARD. Photographic one-grain-layer plates treated with copper sulfate solution before exposure are desensitized by increasing the "gamma" or slope of the normal exposure portion of their characteristic density-log exposure curves, maximum density being reached at approximately the same exposure for both treated and untreated plates. This is contrary to the effect on the original ordinary commercial plates in which the whole curve is shifted by the $CuSO_4$ treatment. The mechanism of the action in each case is probably dissimilar from the action of chromic acid and other oxidizing agents. The former is likely one of adsorption, the latter an oxidation effect. Some experiments on ordinary Graflex plates, treating the latent image with chromic acid for various lengths of time (exposure time constant) showed a gradual increase in destruction of the latent image, until very little remained on 16 hours treatment. Increasing exposures enormously does not increase materially the densities produced. The results are in agreement with previous work on desensitizing with oxidizing agents.

The size-frequency distribution of grains of silver halide in photographic emulsions and its relation to sensitometric characteristics VI. Photographic densities derived from size-frequency data: E. P. WIGHTMAN, A. P. H. TRIVELLI, S. E. SHEPPARD. A method of deriving experimentally the densities for any given exposure, in the characteristic H. and D. (density-log exposure) curve of a simple photographic emulsion from its grain size-frequency distribution has been investigated and briefly is as follows: (1) The size-frequency distribution of the grains per unit area (1 cm²) is obtained; (2) the area-distribution of the different sizes of grains are calculated from this; (3) the area-distribution of residual grains after exposure and development is then found in the same way; (4) from (2) and (3) is then calculated the area-distribution of the developable grains; (5) the expansion ratio of developed to developable grains is found and (6) by means of this the area-distribution of developed grains is obtained; (7) the density for any given exposure and class-size of grains is calculated from the formula $D = \log 1/1 - rn\bar{x}$, where r is the expansion ratio, n the number of developable grains of average size $\bar{x}$; (8) a composite density is obtained from the formula—$D = \log 1/1 - (r_1 n_1 \bar{x}_1 \div r_2 n_2 \bar{x}_2 \div \ldots \div r_n n_n \bar{x}_n$ and not by simply adding the densities for each class size.

The absorption spectra of 2(phenylazo) phenol and its derivatives: JOEL B. PETERSON, C. E. BOORD and A. W. SMITH. Twenty-four derivatives of the "orthohydroxyazobenzene" type were prepared and their absorption spectra photographed in M/15,000 molar solution in 95 per cent. alcohol. The free dyes show a very persistent band in the region 280–380 which is prolonged on the red side almost to 500 for the lower intensities. The p-m-o order of displacement for the mono substituted phenyl derivatives is not evident in this dilution, except for the p-nitro phenyl derivative, which is markedly displaced toward the red. The phenyl, p-chlorophenyl, p-bromophenyl and p-idiophenyl series of derivatives show increasing displacement toward the red in the order given due to the weighing effect. The presence of alkali tends